Claims

What is claimed is:

1. A method for providing improved heat treatment conditions for a precipitation hardenable alloy comprising the steps of:

a) affecting the temperature of the alloy to change an amount of a first precipitate phase relative to an amount of a second precipitate phase;

b) sensing an instantaneous temperature of the alloy and providing a signal in dependence thereof;

c) calculating a value indicative of a current precipitate-phase composition of the alloy according to a series of predetermined rate equations and in dependence upon the provided signal;

d) comparing the calculated value to a predetermined threshold value; and,

e) affecting the alloy in dependence upon a result of the step of comparing,

wherein the predetermined threshold value is characteristic of an alloy having at least one of an indicated yield strength, specific conductivity and corrosion property.

2. A method for providing improved heat treatment conditions according to claim 1 wherein the step a) comprises the steps of:

a1) providing the alloy within an atmosphere for heat treatment;

a2) changing the temperature of the atmosphere according to a predetermined temperature program; and,

a3) waiting for the temperature of the alloy to change.

3. A method for providing improved heat treatment conditions according to claim 2 wherein the step e) includes the step of when the calculated value exceeds the predetermined threshold value, ending the predetermined temperature program.

4. A method for providing improved heat treatment conditions according to claim 2 wherein the step e) includes the step of when the calculated value exceeds the

predetermined threshold value, removing the alloy from the atmosphere for heat treatment.

5. A method for providing improved heat treatment conditions according to claim 2 wherein the step e) includes the step of when the calculated value exceeds the predetermined threshold value, changing further the temperature of the atmosphere according to a second predetermined temperature program.

6. A method for providing improved heat treatment conditions according to claim 1 wherein the step a) comprises the steps of:

a1) providing the alloy within an atmosphere for heat treatment; and,

a2) waiting for the temperature of the alloy to change.

7. A method for providing improved heat treatment conditions according to claim 6 wherein the step e) includes the step of when the calculated value exceeds the predetermined threshold value, removing the alloy from the atmosphere for heat treatment.

8. A method for providing improved heat treatment conditions according to claim 1 wherein the sensor provides the signal in real-time.

9. A method for providing improved heat treatment conditions according to claim 1 wherein the chemical composition of the atmosphere for heat treatment is variably controllable.

10. A method for predicting precipitation kinetics in precipitation-hardenable alloys comprising the steps of:

a) providing an initial value in dependence upon first and second inter-convertible precipitate phases of the alloy;

b) providing data indicative of thermal exposure of the alloy;

c) calculating a value according to predetermined rate equations in dependence upon the provided initial value and the provided data;

d) determining a value indicative of a current precipitate-phase composition of the alloy in dependence upon the calculated value; and,

e) affecting the alloy in dependence upon a result of the step of comparing.

11. A method for predicting precipitation kinetics in precipitation-hardenable alloys according to claim 10 wherein the provided initial value comprises a value indicative of an initial precipitate-phase composition of the alloy.

12. A method for predicting precipitation kinetics in precipitation-hardenable alloys according to claim 11 wherein the provided data is a real-time temperature sensed by a sensor in thermal communication with the alloy.

13. A method for predicting precipitation kinetics in precipitation-hardenable alloys according to claim 11 wherein the provided data is a simulated thermal exposure history of the alloy.

14. A system for providing improved process control for heat treating a precipitation-hardenable alloy comprising:

a holder for accommodating a sample of the precipitation-hardenable alloy, the alloy having first and second inter-convertible precipitate phases;

a temperature controller for affecting the temperature of the sample;

a sensor in communication with the sample for providing a signal in dependence upon a sensed temperature of the sample; and,

a processor for executing code thereon to calculate a value in dependence upon the signal, the value indicative of a current precipitate phase composition of the sample, and for comparing the calculated value to a predetermined threshold value.

15. A system according to claim 14 including a feed back controller responsive to the processor for affecting a characteristic of the process.

16. A system according to claim 15 wherein the feed back controller is for affecting a temperature of the precipitation-hardenable alloy.